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ROCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Cubic-Foot Volume Tables for White Spruce in the Black Hills

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Two tables give volumes in total and merchantable cubic feet. Total volumes include all stemwood from ground line to tip of tree, while merchantable volumes include stemwood from a 1-foot stump to a 4-inch d.i.b. top.

Keywords: *Picea glauca*, volume tables.

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White spruce (*Picea glauca* var. *densata* Bailey) makes up less than 4 percent of the volume of all forest growing stock in the Black Hills. Because of its moderate value and limited occurrence, little need has been felt, up to now, for spruce management working tools. Recent timber sales, however, have included both mixed stands of ponderosa pine and white spruce, and pure spruce stands. These sales have pointed up the increasing need for white spruce volume tables. The two tables presented in this Note give volumes in total and merchantable cubic feet for white spruce in the Black Hills.

Data used to prepare these tables were obtained in 1947 by Black Hills National Forest personnel from a small sample of trees on four timber sales in the Nemo area. Volumes of half-log sections (each 8.15 feet long) to a 4.0-inch d.i.b. (diameter, inside bark) top were computed by Smalian's formula and summed to obtain tree volumes. An additional diameter measurement at 3.5 feet above stump height allowed us to

calculate volumes of butt half-logs in two sections to account for the typical butt swell in the lower bole of white spruce.²

For the total cubic-foot table, the volume of the uppermost section (above the 4.0-inch d.i.b.) was computed as though it were a cone. Stump volumes were computed as cylinders. Thus, total cubic-foot volumes include all stemwood (i.b.) from ground line to the tip of the tree, while merchantable cubic-foot volumes include only the stemwood (i.b.) between a 1.0-foot stump and a 4.0-inch d.i.b. top.

Values in both tables were computed by regressions of the dependent variable, volume (V), on a combined independent variable, diameter at breast height, outside bark, squared (D²) times total height (H). Regression equations are given in table footnotes for use where direct computation of volumes is preferred.

²As a check on the accuracy of Smalian's formula for estimating volume in the butt half-log section, some comparative estimates were made on a sample of trees. Butt half-log volumes were estimated by neiloid formula as well as by planimetry data plotted on standard Forest Service tree measurement forms (Form 558a). These volumes were not substantially different, over the full range of tree sizes, from volumes estimated by Smalian's formula.

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Table 1.--Gross volumes of entire stem in cubic feet, white spruce in the Black Hills

Cubic feet inside bark

Entire stem including stump and top

Total height from ground to tip

| | | | | | | | | | | | | |
|----------------------------------|-----|----------------------|------|------|------|------|------|-------|-------|-----|----|-----------------|
| Diameter | : | Total height in feet | | | | | | | | | : | Basis: Trees |
| breast height | : | | | | | | | | | | : | |
| outside bark | : | | | | | | | | | | : | |
| (Inches) | : | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | : | |
| ----- Volume in cubic feet ----- | | | | | | | | | | | | |
| 5 | 3.3 | 4.0 | 4.6 | | | | | | | | | |
| 6 | 3.8 | 4.8 | 5.7 | 6.6 | | | | | | | | |
| 7 | 4.4 | 5.7 | 6.8 | 8.1 | | | | | | | 2 | |
| 8 | 5.1 | 6.7 | 8.2 | 9.8 | 11.3 | | | | | | 6 | |
| 9 | 5.9 | 7.8 | 9.8 | 11.7 | 13.6 | | | | | | 16 | |
| 10 | | 9.1 | 11.5 | 13.8 | 16.2 | 18.6 | | | | | 7 | |
| 11 | | 10.5 | 13.4 | 16.2 | 19.0 | 21.9 | | | | | 4 | |
| 12 | | | 15.4 | 18.8 | 22.1 | 25.4 | 28.8 | | | | 4 | |
| 13 | | | 17.6 | 21.5 | 25.4 | 29.3 | 33.2 | | | | 5 | |
| 14 | | | 20.0 | 24.5 | 29.0 | 33.5 | 38.0 | | | | 11 | |
| 15 | | | | 27.7 | 32.9 | 38.0 | 43.2 | | | | 1 | |
| 16 | | | | 31.2 | 37.0 | 42.8 | 48.6 | 54.5 | | | 2 | |
| 17 | | | | 34.8 | 41.4 | 47.9 | 54.5 | 61.0 | | | 3 | |
| 18 | | | | 38.7 | 46.0 | 53.3 | 60.6 | 68.0 | | | 3 | |
| 19 | | | | | 50.9 | 59.0 | 67.1 | 75.3 | | | 0 | |
| 20 | | | | | 56.0 | 65.0 | 74.0 | 83.0 | | | 2 | |
| 21 | | | | | | 71.3 | 81.2 | 91.1 | | | 1 | |
| 22 | | | | | | 77.9 | 88.7 | 99.5 | | | 1 | |
| 23 | | | | | | | 96.6 | 108.4 | 120.2 | | 1 | |
| 24 | | | | | | | | 117.6 | | | | |

Basis:

Number trees

69

Block indicates extent of basic data.

Derived from: $V = 2.04 + .00214 D^2 H$.

Standard error of estimate: + 3.35 cubic feet or 13.1 percent.

Tabular values computed from midpoints of diameter and height classes; e.g., midpoint of the 10-inch diameter class is 10.5 and midpoint of the 40-foot height class is 40.

Table 2.--Gross merchantable volumes in cubic feet to a 4.0-inch top, white spruce in the Black Hills

Cubic feet inside bark

Merchantable stem excluding stump and top

Top diameter 4.0 inches inside bark

Stump height 1.0 foot

| | | | | | | | | | | | | |
|----------------------------------|-----|----------------------|------|------|------|------|------|-------|-------|-----|----|--------|
| Diameter | : | Total height in feet | | | | | | | | | : | Basis: |
| breast height | : | | | | | | | | | | : | Trees |
| outside bark | : | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | : | |
| (Inches) | : | | | | | | | | | | : | |
| ----- Volume in cubic feet ----- | | | | | | | | | | | | |
| 5 | 2.7 | 3.3 | 3.9 | | | | | | | | | |
| 6 | 3.2 | 4.0 | 4.9 | | | | | | | | | |
| 7 | 3.7 | 4.9 | 6.0 | 7.2 | | | | | | | 2 | |
| 8 | 4.4 | 5.9 | 7.4 | 8.8 | 10.3 | | | | | | 7 | |
| 9 | 5.1 | 7.0 | 8.8 | 10.6 | 12.5 | | | | | | 17 | |
| 10 | | 8.2 | 10.4 | 12.7 | 14.9 | 17.2 | | | | | 7 | |
| 11 | | 9.5 | 12.2 | 14.9 | 17.6 | 20.3 | | | | | 4 | |
| 12 | | | 14.2 | 17.4 | 20.6 | 23.8 | 25.0 | | | | 4 | |
| 13 | | | 16.3 | 20.0 | 23.8 | 27.5 | 29.0 | | | | 5 | |
| 14 | | | 18.6 | 22.9 | 27.2 | 31.5 | 35.8 | | | | 11 | |
| 15 | | | | 26.0 | 30.9 | 35.8 | 40.7 | | | | 1 | |
| 16 | | | | 29.2 | 34.8 | 40.3 | 45.9 | 51.4 | | | 2 | |
| 17 | | | | 32.7 | 38.9 | 45.2 | 51.4 | 57.7 | | | 3 | |
| 18 | | | | 36.4 | 43.3 | 50.3 | 57.3 | 64.3 | | | 3 | |
| 19 | | | | | 48.0 | 55.8 | 63.5 | 71.3 | | | 0 | |
| 20 | | | | | 52.9 | 61.5 | 70.0 | 78.6 | | | 2 | |
| 21 | | | | | | 67.5 | 76.9 | 86.3 | | | 1 | |
| 22 | | | | | | 73.7 | 84.1 | 94.4 | | | 1 | |
| 23 | | | | | | | 91.6 | 102.8 | 114.1 | | 1 | |
| 24 | | | | | | | | 111.7 | | | | |

Basis:

Number trees

71

Block indicates extent of basic data.

Derived from: $V = 1.45 + .00204 D^2 H$.

Standard error of estimate + 2.99 cubic feet or 12.6 percent.

Tabular values computed from midpoints of diameter and height classes; e.g., midpoint of the 10-inch diameter class is 10.5 and midpoint of the 40-foot height class is 40.